Construction and simulations of full-size CBM-TRD prototypes without drift region*

E. Hellbär, H. Appelshäuser, A. Arend, C. Baumann, T. Bel, C. Blume, P. Dillenseger, K. Reuß, F. Roether, and M. Seidl

Institut für Kernphysik, Goethe-Universität, Frankfurt am Main, Germany

To provide a fast and efficient e/π separation and charged particle tracking for the Compressed Baryonic Matter (CBM) experiment a Transition Radiation Detector (TRD) based on a thin Multiwire Proportional Chamber (MWPC) without an additional drift region is considered [1].

Corresponding to this design two full-size prototypes have been developed and built with an anode-cathode spacing of 4 mm and 5 mm, respectively, resulting in amplification regions of 8 mm and 10 mm depth. The gold-plated tungsten wires with a diameter of 20 μm have a pitch of 2.5 mm. They are glued on distance ledges which are attached to the frame of the detector made out of aluminium with dimensions of 60 $\times$ 60 cm^2. The back side consists of a honeycomb structure supporting the pad plane. The common pad plane design features different pad sizes, where the read-out pads used during tests have a size of 7.125 $\times$ 75 mm^2. A second frame to seal the MWPC includes a thin aluminized mylar foil serving as the entrance window as well as an optional support structure. Figure 1 shows a technical drawing of the prototypes with the aforementioned components.

To avoid large changes of the gas gain due to its deformation the thin mylar foil has to be stretched uniformly and with appropriate tension. To achieve this requirement a method based on thermal expansion is being used [2]. The foil is fixed to a plexiglass frame which is heated up by heating coils resulting in the expansion of the frame and thus a mechanical stretching of the foil. To quantitatively analyse the bulge of the stretched foil caused by overpressure inside the chamber the deformation of the entrance window and the mechanical stress of the MWPC body are simulated with the Abaqus software package [3]. According to these simulations the entrance window stretched at a plexiglass temperature of 55°C gets deformed by 160 μm at an overpressure of 0.01 mbar which is verified by measurements. The resulting gain variation as a function of the modified distance between the entrance window and the anode wires is simulated with Garfield [4] and shown for three detector geometries without drift region in Figure 2. Keeping the deformation of the entrance window below than 120 μm leads to a gain variation of less than 10% and can be achieved by limiting the differential gas pressure variations to less than 0.01 mbar.

The full-size prototypes described in this article were tested along with several other considered prototype geometries with dedicated drift regions at the common test beam campaign at CERN-PS in October 2012 [5][6].

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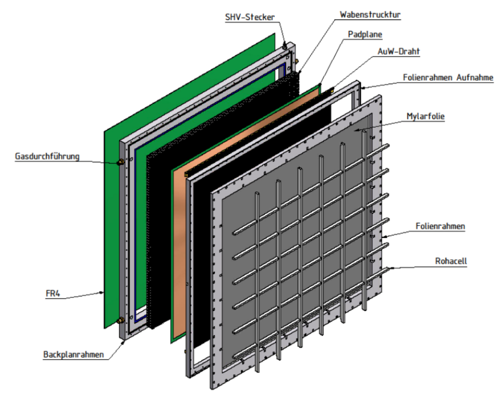

Figure 1: Technical drawing of a full-size TRD-prototype without drift region.

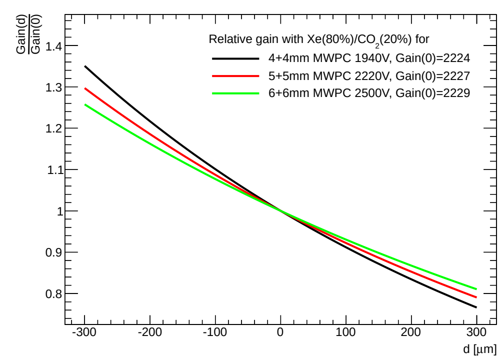

Figure 2: Relative gain depending on the displacement of the entrance window for three detector types without drift region.

References

[1] P. Reichelt, H. Appelshäuser, and M. Hartig, CBM Progress Report 2010, Darmstadt 2011, p. 39.

[2] Michael Staib *et al.*, RD51-Note-2011-004.

[3] http://www.3ds.com/de/products/simulia/portfolio/abaqus/overview/

[4] http://garfield.web.cern.ch/garfield/

[5] P. Dillenseger *et al.*, *In-beam performance studies of the first full-size CBM-TRD prototypes developed in Frankfurt*, this report.

[6] D. Emschermann *et al.*, *Common CBM beam test of the RICH, TRD and TOF subsystems at the CERN PS T9 beam line in 2012*, this report.